DEMOGRAPHIC PARAMETERS OF THE COMMON CRANE (GRUS G. GRUS) POPULATION WINTERING IN IBERIA

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Introduction

Studies on demography of wild animal populations are of fundamental interest in order to try to track their dynamics, to predict their short- and mid-term trends, and to develop management programs for endangered species. Particularly in cranes, little is known about the dynamics and structure of their populations, in spite of their being a group of birds that has been object of numerous studies and conservation efforts during the last years (see revision in *Johnsgard,* 1983). Nevertheless, certain parameters like age-ratio and brood size, which can be best determined by field observations at some wintering areas where these species form large aggregations, may provide important information on the annual recruitment rate of the populations and the average success of the breeding pair. Other studies on the Common Crane *(Grus grus) (Fernandez* et al., 1980; *Sterbetz,* 1986; *Swanberg,* 1981*),* as well as on other crane species *(Blackman,* 1971; *Buller,* 1976; *Crete—Grewe,* 1982; *Drewien,* 1973; *Flint—Kistchinski,* 1981; *Herter,* 1982; *Konrad,* 1981; *Lewis,* 1974; *Libbert,* 1969; *Lovvorn—Kirkpatrick,* 1982; *Nishida,* 1981; *Sauey,* 1976; *Walkinshaw,* 1973*)* give information on these parameters, but certain methodological problems discussed below make comparisons very difficult and sometimes even make it hardly possible to be sure of some of the conclusions. Thus, only methodologically very strict field data recorded, if possible, through several consecutive years, are suitable for analysis, comparison and discussion.

In this paper we give the annual recruitment and average brood size figures for the Common Crane *(Grus g. grus)* population of Western Europe during the years 1979—1985, and discuss the interannual differences observed, and infer from these parameters and recent literature data on breeding success some tentative results concerning the structure of the adult population.

Methods

The basic field work consisted in recording (1) the adult: juvenile ratio and (2) the brood size in the largest possible number of wintering cranes. Sampling was done at random, including unselectively all flocks as they were found in the field. In the "adult" category we included all cranes in nonjuvenile plumage, i. e. more than one year old, while the birds less than one year old were included in the "juvenile" category. This was possible due to the relative ease of recognizing juvenile plumaged birds in winter crane flocks, although in late February—March it is sometimes really difficult to recognize some juveniles, specially under suboptimal light conditions. Such parameters are only valid and representative of the whole population if a large number of birds can be aged each season in the same area and at approxi-

mately equal conditions. The Laguna de Gallocanta, NE-Spain (40°58′ N, 1°30′ W), one of the most important wintering and staging areas of the Western Common Crane population, offered the possibility of recording such data, as a very high percentage of this population stage at it during both migrations. Excellent visibility conditions in this flat area facilitated the field work. The major foraging areas were surveyed by car weekly for two days from October to March each year between 1979 and 1985, except during the spring migrations 1984 and 1985, when the data were recorded daily. In total we aged over 100 000 cranes, of which only the 84505 aged during autumn migration — until 31th December —, and early spring migration, from the date when the first arrivals of flocks from SW until the beginning of the family breakup, which determines a rise in the percentage of juveniles in the study area (see *Alonso* et al., 1984), were analysed in this study. The birds aged during January were also discarded, as the percentage of juveniles increased then significantly with respect to both migratory periods, due probably to the wintering of relatively more families than subadults, nonbreeders or adults without young in the study area. The brood size figures were obtained by recording the number of young for each family recognized as such with complete reliability, i. e. on family groups clearly indentified as a unit within larger flocks or, better, independent of them. First we calculated two yearly values for each parameter, percentage of juveniles and average brood size, one for the autumn, and one for the spring. Both yearly figures were statistically identical in all years studied, enhancing their reliability and representativity, and supporting the idea that the same birds migrate through Gallocanta in autumn and spring. Therefore, for the purposes of this study they were combined into one figure for each year and parameter considered.

Results

The percentage of juveniles and brood size figures are given in table 1. In spite of the small interannual differences, the 1981 values are significantly higher, and the 1983 values significantly lower than most of the other years studied (table 2). The percentage of juveniles divided by the brood size, and multiplied by two gives the wintering number of parents of those juveniles per 100 wintering cranes. For example. for 1979 (see table 1): 12.48% divided by 1.42 and multiplied by 2 is equal to 17.58%.

Table 1.

Annual recruitment, average brood size and percentage of successful breeding adults in the Common Crane 1979—1984

Year	1979	1980	1981	1982	1983	1984	Mean
Percent juveniles in population	12.48	12.95	14.17	12.12	11.67	12.34	12.62
No. cranes aged	5890	6508	20 301	17 991	20 917	12 898	84 505
Average brood size	1.42	1.33	1.44	1.29	1.22	1.33	1.34
No. families identified	45	27	300	382	342	201	1 297
% of total cranes rearing offspring successfully	17.58	19.47	19.68	18.79	19.13	18.56	18.87
% cranes in nonjuvenile plumage rearing offspring successfully	20.09	22.37	22.93	21.38	21.66	21.17	21.60

Table 2.

Tests of interannual differences in brood size (χ^2-test) and annual recruitment (t-test)

	Brood size					
	1979	1980	1981	1982	1983	1984
1979	—					
1980	0.56	—				
1981	0.04	1.11	—			
1982	3.16	0.19	15.07***	—		
1983	8.19**	1.63	32.64***	4.35*	—	
1984	1.47	0.00	5.89*	0.76	6.99**	—

	Annual recruitment					
	1979	1980	1981	1982	1983	1984
1979	—					
1980	0.80	—				
1981	3.31***	2.47*	—			
1982	0.74	1.76	5.91***	—		
1983	1.71	2.79**	7.58***	1.37	—	
1984	0.28	1.23	4.77***	0.58	1.85	—

* $p<0.05$.
** $p<0.01$.
*** $p<0.001$.

From this figure, we can calculate the percent of "adult" birds (in nonjuvenile plumage) that had successfully reared offspring to the next winter that year; in our example, 20.09% of all "adult" cranes.

The percentage of juveniles in the population is a variable that depends on (1) the number of successfully breeding adults, and (2) their average brood size. Actually, the percentage of juveniles is positively correlated with (1) ($r = 0 \cdot 63$; $d.f. = 4$, n. s.) and (2) ($r = 0 \cdot 80$; $d \cdot f \cdot = 4$, $p \simeq 0 \cdot 05$) (table 2). Although the data presented here are of only 6 years and the results of their analysis should therefore be considered as preliminary, the difference between these correlation coefficients is statistically significant ($t = 12 \cdot 80$; $p < 0 \cdot 01$); these results suggest that the interannual variations in the percentage of juveniles depend perhaps more on the variations in the *average brood size* of successful parents (% variance explained $= 100\, r_1^2 = 64\%$) than on the *percent of successful breeders* itself (% variance explained $= 100\, r_1^2 = 40\%$).

Discussion

The brood size

Our preliminary data, with average figures for the six years (1979—1984) of, respectively, 12.62% annual recruitment into the population and 1.34 young reared per successful breeding pair, indicate that the Common Crane, like other cranes

(*Johnsgard,* 1983) has an extremely low reproductive rate. The small interannual variations of the various parameters given suggests, in principle, that this low reproductive rate is probably inherent to the species and associated to its deferred sexual maturity and low clutch size, rather than dependent upon local variable factors such as weather conditions, and degrees of local disturbance or predation. This seems to be, roughly speaking, true but, as discussed below, there are small interannual variations in the various parameters analysed, that could be really reflecting certain influences of extrinsic factors, probably variability in weather and breeding habitat suitability. This can only be tested through detailed studies of the habitat needs of individually marked cranes during reproduction, and careful analysis of the carrying capacity of the breeding habitat in Northern Europe.

The greatest constancy is observed in the successfully and unsuccessfully breeding fractions of the adult population, with coefficients of variation (100σ-$\bar{x}$) of 4.1% and 1.1% respectively. The coefficient of variation of the average brood size is higher (5.6%) and closer to the coefficient of variation of the percentage of juveniles (6.3%). These results, together with the higher correlation of percentage of juveniles with brood size than with percent of successful parents suggest that the small, but significant interannual variability in the annual productivity figures is more influenced by the variations in the raising of one or both young by successful adult pairs than by the percent of successful adult cranes itself, which is apparently more constant from year to year. Thus, the raising of one or both young is probably influenced by external factors, such as weather, food or predation, and seems to be in fact of greatest importance for the annual recruitment of the population, in contrast to the suggestions of *Miller* (1973).

On the structure of the population

Our results indicate that only about one fifth of the nonjuvenile population of cranes represents successfully breeding pairs, the resting 80% of birds in nonjuvenile plumage being either immatures, nonbreeders or unsuccessful breeders. As most of the cranes wintering in Iberia breed in Sweden and other Northwest European countries (*Makatsch,* 1970; *Glutz* et al., 1973; *Swanberg,* 1986), we calculated an average breeding success figure from the data available in the literature for those countries. The average breeding success of 156 Swedish crane pairs was 0.61 young per breeding pair (*Bylin,* 1980; *Nilsson,* 1982; *Swanberg,* pers. comm.), while the success of 649 German pairs was 1.09 young per breeding pair (*Mewes,* 1984; *Neumann,* 1986). The mean figure for the North-western crane population would then be 0.85 young per breeding pair. This means that, from each 100 cranes of the wintering population, 14.85 breeding pairs, or 29.69 breeding adults, would rear the 12.62 young recorded over the last 6 winter seasons in Spain as mean annual recruitment figure (see data in table 1). As the percent of total cranes rearing offspring successfully is, on average, 18.87 (table 1), the unsuccessful breeding pairs would be: 29.69 — 18.87 = 10.82 per 100 birds, and the percent of immatures plus nonbreeders would be: 100 — 12.62 — 18.87 — 10.82 = 57.69 birds. These figures and the corresponding percentages referred to the adult population, are given in table 3. These data would mean that nonbreeding adults plus immatures amount to 66% of the nonjuvenile population. Assuming the population to be stable and the sexual maturity to be acquired, on average, at 3—4 years (*Archibald* pers. comm.; *Johnsgard* 1983), most of these 66% nonjuvenile cranes clearly must be sexually mature birds. Even if we admit that the real age of first breeding is 4—6 years (*Makatsch,* 1970; *Glutz* et al., 1973), and allowing for some annual mortality, about half of these 66% nonjuvenile birds would be real adult cranes that could potentially breed but do not in fact do it.

Table 3.

Summary of data on the Common Crane population structure, based on winter field data and literature references on breeding success (see text)

Category	% of total cranes	% of nonjuvenile population
Juveniles	12.6	—
Successful breeding adults	18.9	21.6
Unsuccessful breeding adults	10.8	12.4
Nonbreeding adults plus immatures	57.7	66.0

A possible reason for that could be that the population is near the carrying capacity of the breeding habitat available. The coexistence of numerous nonbreeders and pairs with high breeding performance fits *Brown's* (1968) model well. This model establishes the exclusion of some individuals from the most suitable habitats and the existence of nonbreeding adults when the population size is too high for the limited area available (see also *Patterson,* 1980). That is, only those pairs settled in optimal habitats would succeed in breeding. The higher correlation of annual recruitment of the population with average brood size than with the percent of successful breeders suggest that good environmental conditions in a given year would benefit relatively more those pairs that had succeeded in occupying the best territories.

It seems, finally, that the current demographic status of the Western population of the Common Crane reflects the high pressure exerted upon it by continual deterioration of the breeding habitats of Central and Northern Europe. However, according to the thesis of higher breeding performance in areas with lower density of breeding pairs (*Perrins,* cit. *Brown,* 1968), the high brood size recorded suggests that at least a fraction of the population nests in areas with adequate breeding densities. If that is true, it would at first view be surprising that more pairs didn't move into these optimal zones, given the pressure exerted by the habitat upon the population. Possibly, some density-regulating mechanisms closely linked to territorial behaviour may also be acting (*Brown,* 1968; *Patterson,* 1980). The older birds, which might be in the best reproductive conditions, would keep a strong territoriality on the best areas, thus enhancing their breeding performance, while other probably younger birds occupying suboptimal habitats or submitted to higher density pressures would fail.

Although we suggest that the population wintering in Iberia might be increasing in certain areas of its breeding range, an appreciable and generalized rise of current population levels seems unlikely without a reestablishment in the breeding areas formerly occupied by the species. If the breeding habitat does not deteriorate any further, the species might maintain its current population level. Finally, some banding would be very desirable, in order to test the hypotheses proposed in this study, as well as to obtain information on mortality rates, which are fundamental to establish a definitive demographic model of the population.

Acknowledgements

Part of the field data were obtained and some of the ideas discussed with *J. P. Veiga.* The CAICYT—CSIC Project No. 22107—01, the Dirección General de Medio Ambiente (MOPU) and the ECPMDMB (ICBP) provided financial support during the field work.

Summary

The percentage of juveniles and the average brood size of wintering Common Cranes *(Grus g. grus)* were recorded at Laguna de Gallocanta, NE Spain from October 1979 to March 1985. The yearly means for percentage of juveniles varied between 11.67% and 14.17%, and the yearly figures for average brood size, between 1.22 and 1.44 young per successful breeding pair. The figures for these six years suggest that the interannual variations in the annual recruitment of young into the population depend more on the variations in the average brood size of successful parents than on the percent of successful breeders itself. This preliminary result and the percentages of successful and unsuccessful breeders, nonbreeders and immatures deduced from the percentage of juveniles and brood size figures, suggest that the West-European population of Common Cranes is near the carrying capacity of the habitat available for suitable breeding.

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A daru (Grus g. grus) Ibériában telelő populációjának demográfiai jellemzői

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Az északkelet-spanyolországi Laguna de Gallocanta térségében telelő daru- *(Grus g. grus)* csapatokban a fiatalok arányát és az átlagos fészekaljszámát vizsgáltuk 1979 októbere és 1985 márciusa között. A fiatalok évenkénti aránya 11,67 és 14,17% között változott; az átlagos fészekaljszám 1,22 és 1,44% között alakult. Az adatokból arra következtethetünk, hogy a populáció évi szaporulatának változásai inkább a sikeresen költő szülők átlagos fészekaljszámán — és nem a sikeresen költő felnőtt madarak arányától — függ. Ez az eredmény, valamint a fiatalok százalékos aránya és a fészekaljadatokból következtetett százalékos arányok (amelyek a sikeresen és a sikertelenül költő, valamint abban az évben nem költő madarakra, a még nem ivarérett példányokra vonatkoznak) arra engednek következtetni, hogy a közönséges nyugat-európai populáció szintje közel áll a rendelkezésre álló költésre alkalmas élőhely eltartóképességéhez.